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Heat-protected thermoplastic component, particularly a vehicle underside component with integrated heat-protection

The present invention concerns a heat-protected thermoplastic component according to the preamble of claim 1, and in particular a vehicle underside component with integrated heat-protection.

Thermoplastic materials such as polypropylene are sensitive to temperature and have a high surface emission potential, or they have an increased heat radiation absorption capacity. This increased absorption of heat radiation results that the matrix of these plastics is intensely heat under the influence of locally variable heat radiation in local areas, thus inducing undesirable weak spots in these areas. Therefore, when using such materials in areas which are exposed to an increased heat radiation, metallic foils are applied which reflect the infrared radiation. Thus the matrix temperature of these plastics in such protection areas can be effectively lowered, i.e. the undesired material mutations such as embrittlement, brittleness etc. can be avoided. This measure allows the use of thermoplastic materials also in environments which are exposed to high temperatures. Without such metallic protective foils, components made of thermoplastic material undergo a rapid aging process and are not usable in environments with increased infrared radiation.

In particular, thermoplastic components are increasingly utilized in modern automotive technology, as they are much lighter in comparison to metallic components, can be user-defined and inexpensively formed, and are easy to recycle. This leads to an ever increasing significance of heat-protection for components used in automotive technology. However, heat protection measures for components in automotive technology have proven to be extremely difficult to implement because of the extreme mechanical strains placed on them such as vibration, wind forces, local temperature fluctuations etc. Currently, such components are provided in a known manner with a metallic foil at their thermally exposed areas in order to protect them at these points from increased infrared radiation. Unfortunately, this well-known measure leads to products which only have a short-term life.

Thus, for example, US 5,464,952 describes an acoustically effective underfloor component for vehicles, having a core layer made of a heat resistant and heat insulating fibrous material. This core layer preferably comprises a non-woven material made of glass fibers, ceramic fibers, basalt wool or mixtures thereof and is provided on both sides with heat reflecting foils made of aluminium or sheet metal in order to reflect any possible infrared radiation which may impinge. The non-woven of this underfloor component is provided at least at its peripheral regions with a duroplastic bonding agent in order to attach the metallic foils to the fibrous non-woven. At the same time this attachment stiffens the peripheral region, which provides the entire underfloor component with a certain form stability. The heat reflecting foils preferably comprise a triple laminate foil having a glass fiber layer, an aluminium layer and a thermoplastic polyolefine layer, so that they may be loosely joined over their entire surface in a form press to the non-woven which, as a rule, is provided with a duroplastic bonding agent. This component also has a relatively stiff peripheral region and a soft, i.e. pliable central region.

In DE 197 05 511 A1 there is described a component utilized as a heat shield comprising a carrier layer made of a thermoplastic synthetic material and a heat protective layer made of aluminium. Between the aluminium layer and the carrier layer there is provided a thermoplastic connection layer (a hotmelt adhesive) made of polypropylene (PP), polyester (PET), polyamide (PA) or thermoplastic polyurethane (TPU), which melts during the forming process and to which the aluminium layer is fixedly bonded at the carrier layer. This aluminium layer is dimensioned to be much larger than the area of maximum heat exposure (hot-spot region) and is intended to dissipate the heat which impinges locally, i.e. essentially convection heat. In order to improve the heat conduction capacity, the aluminium layer utilized preferably has a thickness of 0.08 to 0.2 mm and the surface of the heat shield can be provided with particular deformations. In a preferred embodiment, this heat shield comprises groove-like depressions which run orthogonally to each other, and which are designed to improve the stability and the cooling properties of the heat shield. In order to effect this heat conducting function, this metallic heat protection layer can be in the form of an expanded metal.

Unfortunately it has been shown that these known foils which are covered by a metallic foil and which are subjected to high thermic stress are prone to rapid aging processes, i.e. they remain intact for a short period only. In particular, delamination occurs after a short while in such underfloor components, which makes the use of such components in the automobile industry unsuitable. In particular, the hotmelt adhesive between the metallic protective foil and the carrier material loses its adhesive properties due to the accelerated aging process caused by the high and constantly changing temperature stress. Furthermore, the particularly pronounced vibrations in this area of use provoke such components to rapidly show signs of fatigue, breakage or local decomposition and can lead to undesirable generation of noise.

From WO 99/44851 it is known to provide a fuel tank with an integrated heat protection, and thereby to perforate the reflective metallic foils in such a manner, that the perforation protrusions thus produced are backflowed by thermoplastic synthetic material during the manufacturing process, which leads to a positive mechanically locking (clawing or bracketing) engagement and thus to more durable products. Unfortunately, also with these components, the plastics used in the perforation regions are only inadequately protected against infrared radiation and thus can age more rapidly in these areas.

It is therefore the aim of the present invention to provide a heat-protected thermoplastic component which does not have the mentioned disadvantages and which retains its adhesive properties over its entire surface, even after prolonged use under thermic radiation exposure. In particular, it is the aim of the present invention to provide a heat-protected and vibration-resistant vehicle underside component with a long life span.

This aim is solved according to the invention by a component having the features of claim 1, and in particular by a component having a carrier layer made of a thermoplastic synthetic, in particular an LFT (endless fiber reinforced thermoplast) or a GMT (glass fiber reinforced thermoplast), and a metallic foil connected at least in part thereto, which comprises a multitude of small folding pockets. These folding pockets are embedded in the synthetic mass, i.e. they are mechanically anchored in

the synthetic mass and generate a long-term (i.e. more than 1'000 hours operating time at a temperature of about 140°C) constant peeling resistance W_s of, for example, at least 0.15 N/mm^2 ($W_s > 0.15$ N/mm^2). This anchorage or bracketing of the metallic foil can be easily produced during the forming process of said thermoplastic components, in that a knobbed or similarly formed foil is inserted into a form nest or mold together with the synthetic material to be formed. When the form press is closed, the individual knobs, folds or similar pocket-like elevations are partially compressed, turned-over or folded and form more or less closed folding pockets. When the component is formed, the thermoplastic synthetic can flow around the individual folding pockets, and in this way produces a form-fitting or positive connection with the metallic foil. The technology to form such components by means of a forming process does not require any specific technical knowledge by the expert and is not the subject of the present invention. According to their specific use and function requirements, the individual folding pockets can be variously dimensioned, can be regularly or irregularly arranged, can be coated with other materials, and can be totally or partially circumflowed by plastic. In a preferred embodiment, at least 1 to 5 such folding pockets are arrayed in a sector of 10 to 30 mm. The foil used is preferably made of aluminium and has a thickness of 0.01 to 0.1 mm, but can have a thickness of up to 0.5 mm.

In a further development of the present invention, a heat resistant adhesive is provided between the foil and the synthetic carrier, which does not lose its adhesive properties even under increased thermic stress. It is self-evident that the expert may provide further functional layers between the aluminium foil and the thermoplast.

The component according to the invention is particularly suitable for use in regions of motor vehicles which are subjected to thermal stress, for example in the regions of the underside of the engine compartment, the spare wheel compartment, the vehicle tunnel, the dashboard cowl, the exhaust pipe or catalytic converter, etc.

The advantages of the present invention are immediately obvious to the expert and particularly are to be seen in that, with these components, a closed foil completely protects the synthetic from infrared radiation, thus preventing any delamination. The peeling resistance, a gage for the adhesive properties and vibration resistance,

remains unchanged even after prolonged use, i.e. at higher temperatures, and thus can also be used at regions in vehicles which are subjected to particular exposure to heat. Furthermore, the present invention makes a low-cost production of the inventive components possible, in particular because the shaping process of the thermoplastic material and the fixing or attaching process of the metallic foil to this material can be accomplished in one single method step. Furthermore, it is not necessary to make any perforations, thus enabling a shorter manufacturing time. Therefore, the components according to the invention do not show any long-term signs of flaking or detachment, even under increased vibration or heat stress and thus, when used in vehicles, do not lead to an undesirable generation of noise.

In the following, the invention shall be more closely described with the aid of an exemplary embodiment and with the aid of the Figures. These show:

Fig. 1 a spacial view of a schematically illustrated component according to the invention;

Fig. 2 an enlarged section through a schematically illustrated component according to Fig. 1;

Fig. 3 a graphic illustration showing the long-term performance of the peeling resisitance.

The component 1 shown in Fig. 1 comprises a trough-shaped carrier layer 2 which is suitably formed according to its use. In the view shown, a metallic foil 3 is inserted into this carrier layer 2. According to the invention, this foil 3 comprises a plurality of pocket folds 4 which mechanically couple the metallic foil 3 to the carrier layer 2. The carrier layer is preferably made of a glass fiber reinforced thermoplast (GMB) or a thermoplast filled with endless fibers (LFT). Suitable materials are well known to the expert. Products having endless fibers usually comprise endless fibers in loops or slings, but can also simply be filled with long fibers. The metallic foil is preferably made of aluminium and has a thickness of 0.01 to 0.1 mm. However, it is understood that this foil can be made of a different metallic material, and in particular of a thin steel sheetmetal and have a thickness of up to 0.5 mm. Alternatively, a heat resistant

adhesive layer (hotmelt adhesive) can be provided between this metallic foil 3 and the carrier layer 2, or additional heat insulating or acoustically effective materials can be inserted. In a preferred embodiment, the metallic foil 3 has 1 to 5 inventive folding pockets 4 spaced every 10 to 30 mm. These folding pockets 4 can be differently dimensioned or arranged, according to their use requirements.

Fig. 2 shows a schematic view of a section through a component 1 designed according to the invention. This has at least on one side a metallic foil 3, which, in the finished component 1, should act as a heat reflecting foil. Aluminium is preferably used for this foil 3. This foil 3 is attached to a carrier layer 2 and comprises folding pockets 4 which are embedded in the carrier layer 2. These folding pockets 4 result from the forming process and are completely surrounded by the material of the carrier layer 2. The shaping of these folding pockets 4 leads to a tight coupling, i.e. a form-fitting or positive connection, between the metallic foil 3 and the carrier layer 2. These folding pockets are easily made by using knobbed or otherwise shaped foils for the forming process. According to the intended use, these folding pockets 4 can be differently dimensioned and/or arrayed by the expert. For the present invention it has proven to be particularly beneficial that, for this type of anchorage, the foil 3 does not have to be provided with perforations in order to be able to achieve a positive connection. In particular, the anchorage regions 6, i.e. the regions having the folding pockets 4, are protected against the infrared radiation which damages the thermoplastic material of the carrier layer 2. For other purposes, e.g. acoustic purposes, the expert can, of course, provide the foil 3 with perforations and to use a different material for the carrier layer 2, or to provide a further intermediate layer between the metallic foil 3 and the carrier layer 2. It is thus at the discretion of the expert to include an intermediate layer, for example a hotmelt adhesive, a ceramic layer and/or an acoustically effective layer.

During the shaping process, a metallic foil 3, which has previously been knobbed or has otherwise been provided with geometric deformations, is arranged in a heated form press and is covered with an LFT, GMT or other suitable synthetic material. Thereby the side having the deformations, especially the knobs, faces the synthetic material and these deformations are compressed, crushed or randomly folded when the synthetic material is applied. This leads to the formation of the pocket folds

according to the invention, which permit the flowable plastics material to flow behind the individual pocket folds 4 so as to completely engulf them. It is thus possible to achieve a positive connection in a simple manner. The fibrous plastics material is hardened during the shaping process so as to form the desired carrier layer 2. At the same time, the curing of the plastics layer 2 results in a secure and long-term stable mechanical connection with the metallic foil 3.

Fig. 3 is a graphical illustration of the measurement results to the peeling resistance W_s with different arrangements A, B, C. Here, W_s is understood to mean the ability of the metallic foil to bond to the thermoplastic carrier part, i.e. a gage for the required energy per surface unit to separate the metallic foil 3 from the carrier layer 2. The values in area (I) pertain to arrangements which have not been subjected to an aging process, whilst the values in area (II) pertain to arrangements which have been subjected to temperatures of 140°C during a period of 1000 hours. The values A(I) and A(II) relate to an arrangement A, for which a conventional metallic hotmelt adhesive (MSK25) was used between an LFT-component and an aluminium foil. The measurement results show that no measurable adhesion was obtained.

The values B(I) and B(II) relate to an arrangement B, for which an adhesive being optimized for the bonding of aluminium and polypropylene (HSK15) was used between an LFT-component and an aluminium foil. The measurement values B(I) obtained thereby make it clear that with this arrangement in a non-aged condition, an extremely high peeling resistance $W_s = 1.2\ N/mm^2$ can be achieved. However, the measurement values B(II) show that the peeling resistance after the aging process $W_s = 0.15\ N/mm^2$ is reduced (about 85% reduction of the adhesive value).

The values C(I) and C(II) relate to an arrangement C according to the invention, in which an aluminium foil provided with form pockets is applied to an LFT-component, and between this LFT-component and the aluminium foil no adhesive was used. The peeling resistance resulting from the inventive arrangement C and without the use of an additional adhesive, in a non-aged condition, results in a value of $W_s = 0.2\ N/mm^2$, whilst the peeling resistance for this arrangement C, and after 1000 hours heat treatment, has only decreased to $W_s = 0.16\ N/mm^2$ (about 20% reduction of the adhesive capacity). These measurement results make evident the efficiency of the

present invention. In particular, and without a further inventive step, the expert may suitably adjust and optimize the dimensions and shape of the folding pockets.